BEYQ

ONTARIO

BIOLOGICAL EVALUATION

of the

KAPUSKASING RIVER

north of

THE TOWN OF KAPUSKASING

1970

Ref-72879

B I O L O G I C A L E V A L U A T I O N

of the

K A P U S K A S I N G R I V E R,

North of

T H E T O W N O F K A P U S K A S I N G

1970

DECEMBER, 1971

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1. INTRODUCTION

1.1 PURPOSE AND SCOPE

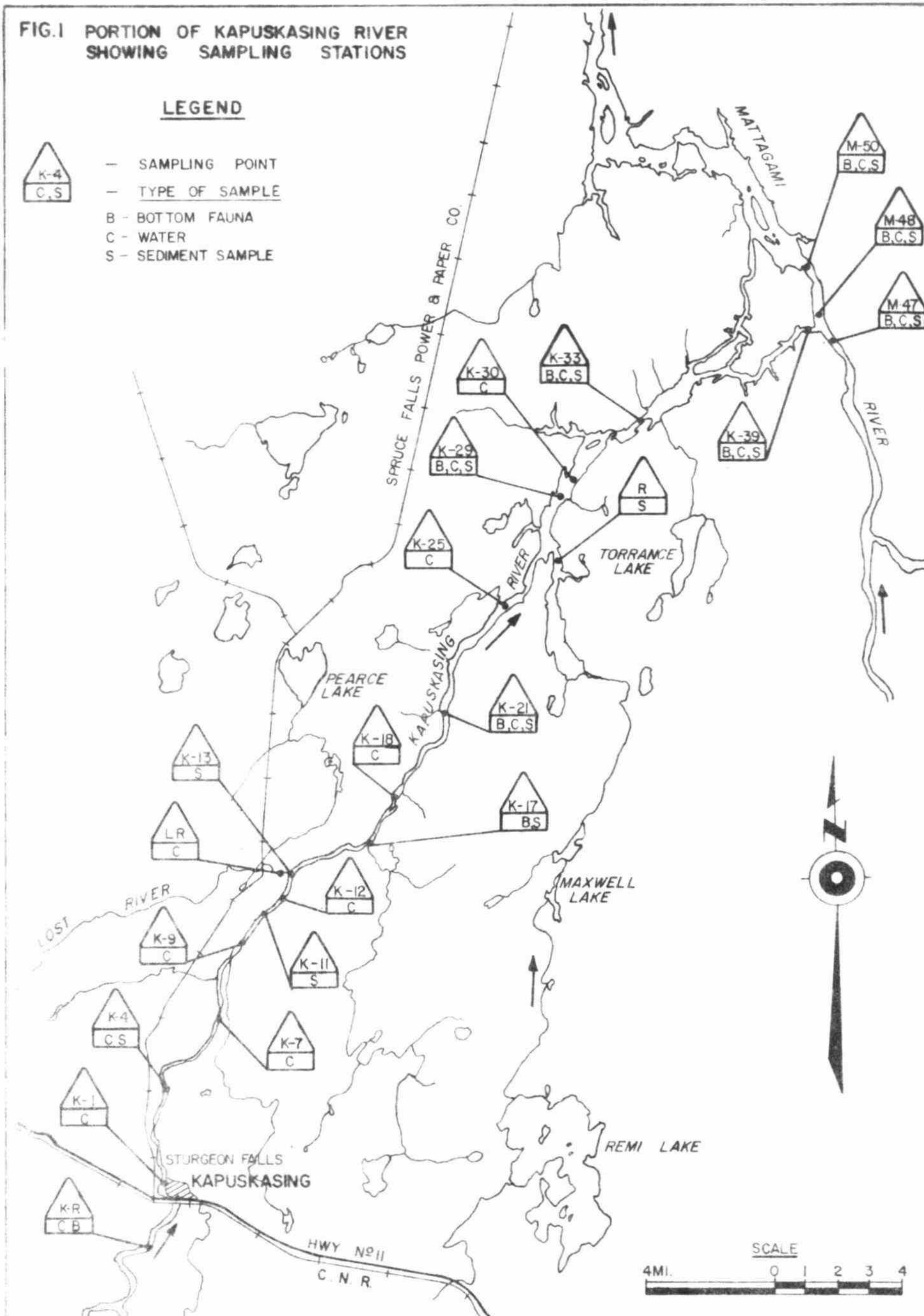
In August of 1970 a study was initiated by the Ontario Water Resources Commission to detail the effects on the Kapuskasing River of discharges from the pulp and paper industry at the town of Kapuskasing. Aspects of the study were investigated by Water Quality Surveys Branch and the Biology Branch. It is the purpose of this report to document the effects of industrial waste discharge on the aquatic biota in the Kapuskasing River. Biological parameters examined include the diversity of benthic invertebrates and the accumulation of zinc and mercury in fish and waterfowl. The biological data were supported by water quality and sediment data collected during the same survey period.

1.2 DESCRIPTION OF THE STUDY AREA

The Kapuskasing River flows north from Kapuskasing Lake to join the Mattagami River, approximately forty miles below the town of Kapuskasing. In turn, the Mattagami River joins the Moose River which empties into James Bay. Among the tributaries of the Kapuskasing River are the Lost River and the Remi River.

In 1969, the Kapuskasing River had a maximum flow of 18,300 cubic feet per second (cfs) (May 8) and the minimum flow of 0 cfs (June 11, 17 and July 4) at the Spruce Falls Dam in Kapuskasing. Measurements on the Mattagami River at Smoothrock Falls showed a maximum flow of

FIG. 1 PORTION OF KAPUSKASING RIVER SHOWING SAMPLING STATIONS



Rivers. These are designated stations LR and R respectively. KR is a réference station taken in the Kapuskasing River upstream of the town of Kapuskasing.

1.3 PREVIOUS WORK

Effluents from pulp and paper mills constitute a serious cause of water pollution in Ontario. The associated problems include high biological oxygen demand (BOD) and an accompanying reduction in the dissolved oxygen concentration, high organic suspended solids loadings, taste and odour problems in fish flesh, and the presence of unsightly mats of floating partially decomposed wood fibre.

Pulp and paper mill wastes generally have a highly detrimental effect on the aquatic ecosystem. In a series of experiments, Smith et al (1963, 1965, 1966, and 1967) demonstrated that wastes from sulphite and groundwood processes increased mortality among fish eggs and fry and caused sublethal physiological changes in mature fish. In addition, toxic and organic pollution from pulp and paper mills exert a detrimental effect on bottom fauna. Unpolluted waters typically support a bottom fauna community containing a variety of species, each of which is represented by a relatively small number of individuals. In contrast, waters organically polluted by pulp and paper mill wastes are characterized by benthic communities of many individuals of only a few species. The organisms present in this polluted environment are typically those which can withstand low dissolved oxygen concentrations.

Toxic pollution, depending on its degree, may severely limit or even eliminate all representatives of the bottom fauna community.

A survey by Conroy (1967) of the Spanish River below the pulp mill at Espanola provides a good example of the effects of toxic and organic pollution on bottom fauna communities. In this study it was found that bottom fauna were completely absent immediately below the main source of mill waste discharge, and that benthic communities for a considerable distance downstream were dominated by pollution tolerant midges and sludgeworms. In the same study, samples taken upstream of the point of waste discharge indicated healthy bottom fauna communities containing many indiginous pollution intolerant forms.

The influence of pulp and paper mill activity usually extends far downstream of the mill, and often precludes alternate uses of the water. A study on the Abitibi River (German 1967) showed that mill wastes from Abitibi Power and Paper Limited at Iroquois Falls were seriously damaging the aquatic ecosystem in the Abitibi River. The distribution and abundance of bottom fauna indicated that the river was severely polluted for 37 miles downstream of the mill and had not completely recovered at 50 miles downstream. Another study by German (1969) indicated that bleached kraft wastes from the Kimberly-Clark Pulp and Paper Company were creating toxic and organic pollution in the western arm of Jackfish Bay, Lake Superior. Impairment of physical, chemical, and biological conditions was detectable to a distance of approximately 1-1/4 miles from the point at which the wastes enter Jackfish Bay.

Conroy (1967) found that the potential multiple use of 35 miles of the Spanish River was seriously limited by the effects of

waste discharges from the pulp mill at Espanola. Use of the lower Spanish River and the adjacent portion of the North Channel of Lake Huron for sport and commercial fishing had been greatly reduced due to the objectionable flavour of fish from these areas. Use of the river for recreational purposes and as a domestic water supply was virtually eliminated by the peculiar odour of the river water.

An additional problem created by some pulp and paper mills has recently come to light. In the past small quanities of mercurials (mercury based compounds) used to reduce slime growths in the mill processes have been discharged in the effluent. Although this practice has been discontinued, it has been found in some areas that the mercury has been concentrated by the biosystem, in some cases to the extent that fish are unacceptable for human consumption (muscle concentrations of mercury greater than 0.5 mg/l, wet weight). Data from above and below a pulp and paper mill on the Ottawa River (Fimreite et al 1971) showed a twofold increase in the concentration of mercury in sauger muscle below the mill which has a history of mercurial use. Also, waterfowl have been found to concentrate mercury in areas where it has been introduced into the environment by man's activity.

2. METHODS

2.1 BIOLOGICAL

Bottom samples were collected at various stations (see figure 1) using a six inch square Ekman Dredge. The dredge is lowered to the bottom in a "set" position and triggered by means of a weighted messenger dropped from surface along the retaining cable. The jaws lock shut when triggered collecting 36 square inches of bottom sediment. The type of sediment determines the depth of penetration of the dredge. The sediment retained by the dredge was emptied into a box screen with a pore spacing of 30 meshes to the inch and washed into one litre wide mouthed jars for transportation to the field laboratory. At the field laboratory the bottom organisms present were removed from the samples and preserved in 70 percent v/v ethanol for subsequent identification and enumeration.

Fish were collected by the Department of Lands and Forests, Kapuskasing District from five areas downstream of the town of Kapuskasing:[1]

1. The mouth of the Lost River (see figure 1)
2. The mouth of the Remi River (see figure 1)
3. 35 miles north of Kapuskasing
4. Mattagami River downstream of Smooth Rock Falls
5. Mattagami River upstream of Smooth Rock Falls

(1) Gill netting in the Kapuskasing River downstream of Kapuskasing was difficult since the high concentration of solid mill wastes carried by the river permanently damaged nets. Therefore, fishing was conducted at the mouths of the Remi and Lost Rivers and in the Mattagami River.

Fish for background information were collected from four areas upstream of the town of Kapuskasing:

1. Mouth of Shanley Creek
   (30 miles upstream of Kapuskasing)
2. Mouth of Graveyard Creek
   (33 miles upstream of Kapuskasing)
3. 35 miles upstream of Kapuskasing
4. Six miles upstream of Kapuskasing

The fish were frozen and submitted to the Ontario Water Resources Commission for analysis of mercury concentrations. Samples of fish muscle were emulsified, digested and subsequently analyzed by atomic absorption spectrophotometry.

Waterfowl were collected by the Department of Lands and Forests, Kapuskasing District, at two waterfowl banding stations; in the vicinity of station K21, and Hull Creek approximately ten miles east of the confluence of the Lost and Kapuskasing Rivers. The ducks were frozen and submitted to the Ontario Water Resources Commission for metal analyses including concentrations of mercury, lead, zinc, chromium, copper and iron. The birds were identified to species and sexed and aged (immature or mature). Various tissues including breast muscle, liver, kidney and brain were emulsified and digested in preparation for analysis. Metal concentrations were determined by atomic absorption spectrophotometry.

2.2 CHEMICAL

Water samples for chemical analysis were collected at stations KR, K1, K4, K7, K9, K12, LR, K18, K21, K25, K29, K33, K39, M47, M48, M50. At each of these stations, 1 litre glass bottles of water from a depth of one-half meter were collected and submitted for routine chemical analyses. The parameters investigated are shown in table IV of the Appendix. At stations KR, K4, K7, LR, K21, K30, K39, M47, M50 a one litre sample was collected in a polyethylene bottle for the determination of mercury, lead and zinc concentrations.

The dissolved oxygen concentration at various stations in the river was determined by the Water Quality Surveys Branch during an investigation on September 23 and 24, 1970. Their data is summarized in this report.

Sediment samples for mercury and zinc analyses were collected with a six inch square Ekman dredge at stations K4, K11, K13, K17, K21, K29, R, K33, K39, M47, M48 and M50. The samples were retained in polyethylene bags and submitted to the Ontario Water Resources Commission for analyses.

3. RESULTS & INTERPRETATION

3.1 BIOLOGICAL

Bottom Fauna

The results of the biological examination of bottom sediments are summarized in Table 3.1 below. The data are included in Table 1 of Appendix B. A simplified index of diversity provided by Margelef (1968), as I.D.=$S-1/\log_e N$ where S = number of taxa and N = number of individuals is shown in table 3.1 (for explanation see Appendix A).

At reference stations in the Kapuskasing River upstream of Kapuskasing the index of diversity varied from 0.8 to 1.7 with a mean of 1.4. Pollution intolerant invertebrates such as immature mayflies, alderflies and caddisflies were present, as well as relatively low numbers of facultative and tolerant species such as claims, leeches, midges and worms.

Samples dredged from the river below the mill at distances of four, eleven and thirteen miles showed no bottom fauna organisms although substantial effort was not made to secure biological samples since conditions at these points showed obvious impairment of water quality to the extent that backwater bays and lee-shore areas were choked with decaying mats of fibre and bark. Indeed the river banks in some areas were lined with fibre and bark deposits to depths of approximately six feet.

TABLE 3.1.1

DIVERSITY OF BOTTOM FAUNA IN THE KAPUSKASING RIVER AUGUST, 1970

Station	Date	# of Organisms	# of Taxa	Index of Diversity
KR a.	10/8	61	8	1.69
KR b.	10/8	48	4	.78
KR c.	10/8	6	4	1.68
K4	11/8	0	0	0.00
K11	11/8	0	0	0.00
K13	11/8	0	0	0.00
K17	11/8	128	3	.41
K21	11/8	303	3	.35
R	13/8	103	4	.65
K29	11/8	152	2	.20
K33	13/8	500	1	0.00
K39 a.	13/8	6	1	0.00
K39 b.	13/8	100	1	0.00
M47 a.	13/8	346	8	1.20
M47 b.	13/8	359	6	1.19
M48 a.	13/8	515	2	.16
M48 b.	13/8	49	2	.26
M50 a.	13/8	78	4	.69
M50 b.	13/8	52	7	1.52

At station K 17 a single sample of bottom fauna showed a low diversity and in excess of three hundred organisms in the one quarter square foot area sampled. The community was dominated by pollution tolerant sludgeworms.

No significant improvement in bottom fauna conditions was noted in the remaining twenty-two miles of the Kapuskasing River to station K 39.

Some impairment in the Mattagami River was indicated from samples collected at station M 48 and M 50, downstream of the confluence of the Kapuskasing and Mattagami Rivers. At these stations diversity was low and pollution tolerant and pollution facultative taxa such as worms, leeches, snails and clams dominated the community.

At M 47 in the Mattagami River upstream of the confluence with the Kapuskasing River, the community was dominated by worms in excess of 300 per quarter square foot of bottom. However, pollution tolerant caddisflies and mayflies were also present at this station in substantial numbers. The large population of worms may be a response to the loading from the pulp and paper installation at Smooth Rock Falls,although further work on the Mattagami River would be necessary to clearly define the effects of this potential pollution source.

Fish

A summary of mercury concentrations in fish muscle from the Kapuskasing River area is provided in table 3.1.2. The data appear in Appendix B, Table II. Mercury levels in samples from all stations on the Kapuskasing River, including the mouths of the Lost and Remi River, almost invariably exceeded the level considered acceptable for human consumption (0.5 mg/l, net weight). The only notable exception occurred at the station 30 miles upstream of the town of Kapuskasing where most of the mercury concentrations approached, but did not exceed the 0.5 mg/l level. Except for the comparatively low values noted at this station, mercury concentrations in fish upstream of Kapuskasing generally proved very similar to concentrations found downstream. Pike and walleye were found to contain higher levels of mercury than suckers and burbot from the same areas. Also, it was noted that large fish contained greater concentrations of mercury than did small fish of the same species.

Samples taken from the Mattagami River generally contained considerably lower levels of mercury than samples from the Kapuskasing River. No significant difference in concentrations was found between samples taken above and below the mill at Smoothrock Falls.

Waterfowl

The results of the metal analyses performed on waterfowl tissues are shown in Table III of Appendix B. To date, little information has been collected concerning the significance of metal concentrations in waterfowl, therefore, no interpretation can be made from much of the data presented in Table III. In general,however,

the metals, mercury, zinc, copper and iron,were found in nearly all samples of all tissue,while lead and chromium were detected in only a few specimens[1]. Also, the concentrations of all metals were higher in liver and kidney tissues and lower in brain and muscle tissues.

The mercury concentration was slightly higher in ducks from the Hull Creek area (reference area) than from the Kapuskasing River. Fimreite et al (1971) provides data on the concentration of mercury in liver tissue from adult black ducks. These specimens which were taken from the Ottawa River in the vicinity of Baie Noire had a mean mercury concentration of 0.38 mg/l wet weight and a range of 0.02 to 0.77 mg/l (5 specimens). The mean concentration of five juvenile black ducks from the Hull Creek area was significantly higher at 0.83 mg/l wet weight (range of 0.35 to 1.90) while a similar sample from the Kapuskasing River had a lower mean concentration (0.23 mg/l) and a range of 0.02 to 0.43 mg/l). Muscle tissue from a single immature mallard duck collected from the Hull Creek area had a concentration of 0.62 mg/l wet weight which is higher than the recommended safe concentration for human consumption (equal to or less than 0.5 mg/l). The value is, however, considerably less than the concentrations reported in Chemical and Engineering News (1971) from samples taken from the Wabigoon River west of Dryden, Ontario. Mallards from that area had a mean mercury concentration of 4.8 mg/l wet weight.

[1] Since some of the ducks were captured by shooting it is suspected that some of the lead concentrations are the result of contamination by lead shot.

TABLE 3.1.2

MEAN CONCENTRATIONS AND RANGES OF MERCURY IN NORTHERN PIKE AND WALLEYE MUSCLE TISSUE FROM THE KAPUSKASING RIVER AND VICINITY

Location	MEAN	RANGE	# OF FISH
Kapuskasing River - 35 miles upstream of Kapuskasing	1.22	1.1 - 1.4	4
Kapuskasing River - 33 miles upstream of Kapuskasing	.86	.43- 1.2	3
Kapuskasing River - 30 miles upstream of Kapuskasing	.49	.30- .85	6
Kapuskasing River - 6 miles upstream of Kapuskasing	1.4	--	1
Lost River (mouth)	1-10	1.08-1.13	2
Remi River (mouth)	1.13		1
Kapuskasing River - 35 miles downstream of Kapuskasing	1.47	.72-1.9	16
Mattagami River upstream of Smoothrock Falls	.28	.12- .57	20
Mattagami River downstream of Smoothrock Falls	.45	.28- .61	4

3.2 CHEMISTRY

Water

The results of the chemical analyses of water samples collected during the survey are provided in table IV of Appendix B.

The dissolved solids concentration doubled downstream of Kapuskasing (from 80 to 175 mg/l) and remained elevated throughout the river. In the Mattagami River at station M50, the dissolved solids concentration was as low as at the reference station in the Kapuskasing River (KR). A large fraction of the increase in the dissolved solids concentration was due to an increase in undissociated material since the conductivity increased by only 15 percent. Significant increases were observed in the sulfate concentration and the phenol concentration. Both of these parameters showed nearly a twofold increase over the reference station at KR. In the case of phenol concentrations there was an elevation at KR (7.0 ugm/l) when compared with the Lost River, station LR (0.0 ugm/l).

The relatively high concentration of phenols at KR is probably related to the transportation and booming of pulp logs in the river upstream of Kapuskasing.

Only trace quantities of the heavy metals, mercury, lead and zinc were found in the water and no significant increase was observed downstream of Kapuskasing.

Dissolved oxygen concentrations as measured on September 23 and 24 are shown in table 3.2.1.

TABLE 3.2.1

DISSOLVED OXYGEN CONCENTRATIONS IN THE

KAPUSKASING RIVER, SEPTEMBER 23 & 24, 1970

Station	Dissolved Oxygen mg/l (mean)	Saturation %	Station	Dissolved Oxygen mg/l (mean)	Saturation %
KR	8.5 (3)	87	K26	0.9	9
K0	7.3 (5)	74	R	6.1	60
K2	6.8	68	K31	0.9	8
K6	5.7	57	K35	1.55 (6)	15
K11	2.9	41	K36	1.60	15
LR	7.8	78	K37	1.43 (6)	14
K16	1.4	14	K38	1.54	15
K21	0.7	7	K39	1.64	16

(_) = number of samples; where indication is not provided number of samples = 7

The data indicates that the pulp and paper activity at Kapuskasing was significantly reducing oxygen concentrations downstream of Kapuskasing. The greatest reduction occurred some distance below Kapuskasing (K21). The oxygen concentration at this station was only 7 percent saturation (mean of 7 samples). The entire river from station K11 to K39 was unsuitable for the maintenance of a fishery (dissolved oxygen concentration less than 4.0 mg/l). The bottom fauna distribution

was similar to the distribution of dissolved oxygen in that recovery of the bottom fauna community from the pollution was not complete at the mouth of the Kapuskasing River.

Sediments

The concentrations of mercury and zinc in bottom sediments at selected stations in the Kapuskasing River are shown in Table 3.2.2. These data show that the concentrations of the two metals generally correspond, that is, low mercury values are associated with low zinc values. A wide range in both mercury and zinc concentrations was noted (0.0 to 3.00 mg/l and 29. to 140 mg/l respectively).

This range is probably related to the mechanisms of transport of the fibre load since it has been found that metals including mercury and zinc are easily adsorbed on suspended organic matter. (Hem. 1970, and Abbot, 1970). In the case of the pulp and paper industry with high fibre loading the metals are probably transported in the fibre loading.

The values reported in Table 3.2.2 for mercury are generally within the range expected in freshwater sediments. Pierce et al (1970) found that 80% of stream sediments investigated in western continental United States and Alaska contain less than 1. ppm mercury. Stations R, K33 and M48 show considerably higher concentrations than expected in uncontaminated sediments.

The results of the survey show that sediment concentrations of either mercury or zinc did not correlate with water born concentrations (see table IV of the appendix and table 3.2.2. Studies of other pulp mills which discharge zinc support this finding (O.W.R.C. 1970).

TABLE 3.2.2.

MERCURY AND ZINC CONCENTRATIONS IN BOTTOM SEDIMENTS FROM THE KAPUSKASING RIVER, AUGUST 1970

STATION	MERCURY (mg/l)	ZINC (mg/l)
K4	0.43	73.0
K11	0.00	68.0
K13	0.20	130.0
K17	0.31	140.0
K21	0.20	35.0
K29	0.32	51.0
R	2.10	110.0
K33	2.80	120.0
K39	0.10	69.0
M47	0.02	29.0
M48	3.00	130.0
M50	0.25	53.0

4. SUMMARY

The results of biological and chemical testing indicate gross impairment of water quality in the Kapuskasing River downstream of the town of Kapuskasing. Depressed bottom fauna communities, low dissolved oxygen concentrations, and significant elevations in waterborne sulphate and phenol levels were noted throughout this section of the river. Only trace quantities of the metals mercury, lead and zinc were detected in the water and no increases below the pulp and paper mill at Kapuskasing were noted.

Abnormally high concentrations of mercury were occasionally found in the bottom sediments, however, the majority of samples collected showed concentrations within the range expected for freshwater sediments. Zinc concentrations generally correlated with mercury concentrations in bottom sediments.

Mercury concentrations in northern pike and walleye flesh from the Kapuskasing River were generally higher than the recommended safe level for human consumption. No significant difference in mercury levels between fish taken above and below Kapuskasing could be determined. Fish from the Mattagami River generally contained much lower mercury concentrations than fish from the Kapuskasing River.

Only one sample of waterfowl muscle contained a concentration of mercury greater than the suggested upper limit for human consumption.

Extensive bark and wood fibre accumulations were noted at various areas along the Kapuskasing River, particularly on

the banks and in backwater areas. Floating fibre mats were observed frequently throughout most of the river.

Numerous dead fish were observed at various locations on the Kapuskasing River during the survey period.

ACKNOWLEDGMENTS

The Kapuskasing District office of the Ontario Department of Lands and Forests assisted in the study by providing information and equipment as well as in collecting specimens of fish and waterfowl.

The assistance of Mr. C. W. Ross, summer student on the survey, is gratefully acknowledged.

REFERENCES CITED

Abbott, R.A. 1971. Zinc hydrosulphite usage as a source of zinc in pulp and paper mill effluents. Report of the Ontario Water Resources Commission.

Anon, 1969. Provisional Report - streamflow data, Water Survey of Canada.

Anon, 1971. Mercury in Ducks Chemical and Engineering News 49(40):32.

Colby, P.J., and Lloyd L. Smith, Jr. 1967. Survival of walleye eggs and fry on paper fibre sludge deposits in the Rainy River, Minnesota.

Conroy, N. I. 1967. Water quality evaluation of the lower Spanish River. Report of the Ontario Water Resources Commission.

Fimreite, N.; W. N. Holsworth; J. A. Keith; P.A. Pearce, and I.M. Gruchy, 1971. Mercury in Fish and Fish-eating Birds near Sites of Industrial Contamination in Canada. The Canadian Field Naturalist 85:211-220.

German, M. J. 1967. Biological survey of the Abitibi River. Report of the Ontario Water Resources Commission.

German, M. J. 1969. Biological evaluation of the pollution status of Jackfish Bay, Lake Superior. Report of the Ontario Water Resources Commission.

Gillies, N.A. 1968. A report on an industrial wastes survey of Spruce Falls Power and Paper Company Limited, Kapuskasing. Report of the Ontario Water Resources Commission.

Hem, J. D. 1970. Chemical behaviour of mercury in aqueous media. Professional Paper 713 pages 19-24. U.S. Government printing Office, Washington.

Margelef, R. 1968. Perspectives in ecological theory. University of Chicago Press, Chicago.

Pierce, A. P.; J. M. Botbol, and R. E. Learned. 1970. Mercury content of rocks, soils, and stream sediments in Mercury in the Environment, Geological Survey Professional Paper 713 pages 14-16. U. S. Government Printing Office, Washington.

Smith, L. L. Jr., and R. H. Kramer, 1963. Survival of walleye eggs in relation to wood fibres and Sphaerotilus natans in the Rainy River, Minnesota. Trans. Amer. Fish Soc. 92:220-234.

Smith, L. L. Jr.; R. H. Kramer, and J. C. MacLeod, 1965. Effects of pulpwood fibres on fathead minnows and walleye fingerlings. J. Water Poll. Cont. Fed. 37:130-140.

Smith, L. L. Jr.; R. H. Kramer, and Donovan, M. Oseid, 1966. Long-term effects of conifer groundwood paper fibre on walleyes. Trans. Amer. Fish Soc. 95:60-70.

APPENDICES

APPENDIX A: DIVERSITY, AND WATER QUALITY

APPENDIX B: DATA TABLES

APPENDIX A

BIOLOGICAL EVALUATION OF WATER QUALITY

The aquatic biological community is sensitive to relatively small changes in the aquatic environment and tends to reflect these conditions over a finite period of time. The length of the time span is a function of the duration of the life cycle of the components of that community.

In natural water (unpolluted) the community is typically composed of a wide variety of organisms with no one form numerically dominating. Pollution specializes the environment and many of the niches (functional zones) which were available in the natural situation are eliminated. The elimination of niches reduces the number of different types of organisms which are capable of surviving.

In the case of non-toxic pollution the organisms capable of adapting to the new environment begin to numerically dominate the community. For example, in severe situations where organic pollution is involved the bottom-dwelling invertebrate community will be composed of many thousands of pollution tolerant sludgeworms per square foot of bottom.

Quantitatively, a measure of species diversity aids in determining the extent of water quality impairment. Many indices of species diversity have been proposed including the one used herein as put forth by Margalef (1968) as $D = S-1/\log_e N$ where $\underline{S}$ is the number of species and $\underline{N}$ is the number of individuals. The index is maximum when all species belong to different species and minimum (zero) when all individuals belong to the same species.

Qualitatively, certain species in the community can be considered to be indicators of the pollution status of the water surrounding the habitat. Bottom-dwelling invertebrates can be catagorized on the basis of their relative tolerance to pollution as tolerant, falcultative or intolerant.

Both of these methods, diversity and indicator organisms, are utilized in the interpretation of the results of this survey.

APPENDIX B: DATA TABLES

TABLE 1

BOTTOM FAUNA FROM THE KAPUSKASING RIVER

1970

Station	Date	Caddisflies	Mayflies	Alderflies	Fishflies	Midges	Other Diptera	Amphipods	Worms	Leeches	Snails	Clams
KR a.	10/8	5	3	1		36		1	12	2		1
KR b.	10/8	2				43			2	1		
KR c.	10/8	1				1			3	1		
K4	11/8											
K11	11/8											
K13	11/8											
K17	11/8					52			75			1
K21	11/8					2			300+			1
R	13/8					32			50+		4	17
K29	11/8					2			150+			
K33	13/8								500+			
K39 a.	13/8								6			
K39 b.	13/8								100+			
M47 a.	13/8	20	4		1	4			300+	2	1	14
M47 b.	13/8	16	5			8			300+	17		13
M48 a.	13/8					15			500+			
M48 b.	13/8					1			48			
M50 a.	13/8					14			4		10	50+
M50 b.	13/8		1			18	4		1	2	14	12

+ = greater than

TABLE 11

MERCURY CONCENTRATIONS IN FISH MUSCLE

FROM THE KAPUSKASING RIVER AND VICINITY, 1970

LOCATION	SPECIES	WEIGHT grams	MERCURY mg/L
Kapuskasing River 35 miles upstream of the town of Kapuskasing	Northern Pike	-	1.4
	Northern Pike	-	1.3
	Walleye	-	1.1
	Walleye	-	1.1
Kapuskasing River 33 miles upstream of the town of Kapuskasing (mouth of Graveyard Creek)	Walleye	707	.43
	Walleye	990	.95
	Walleye	1047	1.2
Kapuskasing River 30 miles upstream of the town of Kapuskasing (mouth of Shanley Creek)	Walleye	908	.85
	Walleye	198	.44
	Walleye	170	.51
	Walleye	226	.45
	Walleye	226	.30
	Walleye	226	.37
Kapuskasing River 6 miles upstream of the town of Kapuskasing	Walleye	1480	1.4
Lost River (mouth)	Northern Pike	2098	1.08
	Walleye	1418	1.13
	Burbot	50	.34
	White Sucker	1771	.76
	White Sucker	820	.23
Remi River (mouth)	Northern Pike	2035	1.13
	White Sucker	1323	.78
	White Sucker	113	.26
Kapuskasing River 35 miles downstream of the town of Kapuskasing	Northern Pike	-	1.4
	Northern Pike	-	1.4
	Northern Pike	-	1.4
	Northern Pike	-	1.1
	Northern Pike	-	1.2
	Northern Pike	-	1.3
	Northern Pike	-	1.6
	Northern Pike	-	1.9
	Northern Pike	-	.72
	Northern Pike	-	.96
	Northern Pike	-	1.2
	Northern Pike	-	1.5
	Northern Pike	-	1.5
	Northern Pike	-	2.2
	Walleye	-	2.0
	Walleye	-	2.1

cont.

LOCATION	SPECIES	WEIGHT grams	MERCURY mg/L
Mattagami River upstream of the dam of the dam at Smoothrock Falls	Walleye	480	.50
	Walleye	500	.34
	Walleye	240	.28
	Walleye	560	.33
	Walleye	10	.22
	Walleye	160	.28
	Walleye	140	.23
	Walleye	170	.23
	Yellow Perch	-	.09
	Burbot	220	.12
	Northern Pike	240	.21
	Northern Pike	220	.20
	Northern Pike	130	.13
	Northern Pike	160	.20
	Northern Pike	180	.20
	Northern Pike	50	.12
	Northern Pike	360	.18
	Northern Pike	100	.18
	Northern Pike	340	.24
	Northern Pike	590	.57
	Northern Pike	1040	.36
	Northern Pike	1120	.52
Mattagami River downstream of the dam at Smoothrock Falls	Northern Pike	610	.28
	Northern Pike	750	.41
	Northern Pike	1230	.61
	Walleye	260	.50
	Longnose Sucker	1160	.16
	Longnose Sucker	1400	.43
	Longnose Sucker	1120	.24

TABLE III

THE CONCENTRATION OF VARIOUS METALS

IN SELECTED WATERFOWL TISSUES, 1970.

BRAIN

TABLE III

HULL CREEK

Species and Age	Hg	Pb	Zn	Cr	Cu	Fe
Juvenile Mallard	.20	0.0	11.0	0.0	4.6	-
Juvenile Mallard	.08	0.0	9.0	0.0	2.5	-
Juvenile Mallard	.57	0.0	8.1	0.0	0.0	-
Juvenile Black	.17	0.0	9.2	0.0	0.0	-
Juvenile Black	.13	0.0	7.6	0.0	0.0	-
Juvenile Black	.10	0.0	9.3	0.0	0.0	-
Juvenile Black	.18	0.0	9.4	-	-	-
Juvenile Black	.09	0.0	11.4	-	-	-

KAPUSKASING RIVER

Species and Age	Hg	Pb	Zn	Cr	Cu	Fe
Juvenile Mallard	.25	0.0	13.0	0.0	2.0	-
Juvenile Black	.67	0.0	9.3	0.0	2.7	-
Juvenile Black	.12					
Juvenile Black	.13	0.0	10.0	0.0	1.5	215.0
Juvenile Black	.05	0.0	7.9	0.0	2.2	14.0
Juvenile Black	.03	0.0	10.0	0.0	0.0	66.0
Juvenile G.W. Teal	.04	0.0	11.0	0.0	0.0	16.0
Juvenile G.W. Teal	.11	0.0	17.0	0.0	9.2	-
Juvenile G.W. Teal	.15	0.0	12.0	0.0	5.0	40.0
Juvenile B.W. Teal	.55	0.0	15.0	0.0	0.0	-
Juvenile B.W. Teal	.30	-	-	-	-	-
Juvenile Baldpate	.04	0.0	4.7	0.0	0.0	27.0
Juvenile Baldpate	.12	0.0	20.0	0.0	7.7	-
Juvenile Baldpate	.01	-	27.0	0.0	0.0	-
Adult Mallard	.16	165.0	11.0	-	-	-
Adult Baldpate	.44	0.0	12.0	0.0	5.0	-

TABLE III Cont'd

MUSCLE

HULL CREEK

Species and Age	Hg	Pb	Zn	Cr	Cu	Fe
Juvenile Mallard	.19	1.8	10.7	-	-	-
Juvenile Mallard	.06	0.8	7.9	-	-	-
Juvenile Mallard	.62	0.0	10.7	-	-	-
Juvenile Black	.07	0.7	7.8	-	-	-
Juvenile Black	.26	0.0	7.1	-	-	-
Juvenile Black	.09	0.5	10.5	-	-	-
Juvenile Black	.18	0.0	9.4	-	-	-
Juvenile Black	.09	0.0	11.4	-	-	-

KAPUSKASING RIVER

Species and Age	Hg	Pb	Zn	Cr	Cu	Fe
Juvenile Mallard	.16	0.0	8.3	-	-	-
Juvenile Black	-	1.1	12.9	-	-	-
Juvenile Black	.11	1.9	5.9	-	-	-
Juvenile Black	.17	0.0	8.2	0.0	3.2	54.0
Juvenile Black	.06	0.0	8.6	0.0	3.3	35.0
Juvenile Black	.16	0.0	25.0	12.8	0.0	110.0
Juvenile G.W. Teal	.04	6.5	7.3	0.0	2.9	43.0
Juvenile G.W. Teal	.13	7.4	6.5	-	-	-
Juvenile G.W. Teal	.30	0.0	11.7	0.0	0.0	86.0
Juvenile B.W. Teal	.29	10.0	6.3	-	-	-
Juvenile Baldpate	.02	0.0	11.0	30.0	0.5	156.0
Juvenile Baldpate	.23	0.0	0.9	5.7	1.9	61.0
Juvenile Baldpate	.04	0.0	0.5	0.0	2.4	70.0
Adult Mallard	.07	0.0	12.2	0.0	0.0	73.0
Adult Baldpate	.17	0.0	7.0	-	-	-

LIVER

TABLE III Cont'd

HULL CREEK

Species and Age	Hg	Pb	Zn	Cr	Cu	Fe
Juvenile Mallard	.83	0.0	31.0	0.0	28.0	-
Juvenile Mallard	.48	0.0	19.0	0.0	90.0	-
Juvenile Mallard	1.40	0.0	33.0	0.0	26.0	-
Juvenile Black	.64	0.0	33.0	0.0	15.0	-
Juvenile Black	1.90	0.0	38.0	0.0	35.0	-
Juvenile Black	.35	0.0	24.0	0.0	15.0	-
Juvenile Black	.44	0.0	27.0	0.0	26.0	-
Juvenile Black	1.30	0.0	29.0	0.0	30.0	-

KAPUSKASING RIVER

Species and Age	Hg	Pb	Zn	Cr	Cu	Fe
Juvenile Mallard	.75	0.0	32.0	0.0	23.0	-
Juvenile Black	.43	0.0	31.0	0.0	22.0	-
Juvenile Black	.22	0.0	42.0	0.0	30.0	350.
Juvenile Black	.02	0.0	29.0	0.0	16.0	290.
Juvenile Black	.36	0.0	32.0	0.0	9.0	30.0
Juvenile Black	.13	0.0	32.0	0.0	15.0	250.
Juvenile G.W. Teal	.09	0.0	35.0	0.0	25.0	160.
Juvenile G.W. Teal	.20	0.0	3.0	0.0	18.0	-
Juvenile G.W. Teal	.69	0.0	41.0	0.0	26.0	430.
Juvenile B.W. Teal	.17	0.0	33.0	8.2	27.0	-
Juvenile B.W. Teal	.26	0.0	38.0	1.9	9.0	660.
Juvenile Baldpate	.03	0.0	24.0	0.0	11.0	195.0
Juvenile Baldpate	.33	0.0	41.0	0.0	37.0	-
Juvenile Baldpate	.07	0.0	44.0	0.0	27.0	280.
Adult Mallard	.18	0.0	35.0	0.0	31.0	520.
Adult Baldpate	.99	0.0	32.0	4.3	28.0	-

TABLE III Cont'd

KIDNEY

HULL CREEK

Species and Age	Hg	Pb	Zn	Cr	Cu	Fe
Juvenile Mallard	.84	0.0	25.0	0.0	4.0	-
Juvenile Mallard	.11	0.0	17.0	0.0	0.0	-
Juvenile Mallard	1.9	0.0	20.0	0.0	3.8	-
Juvenile Black	.72	0.0	21.0	0.0	15.0	-
Juvenile Black	1.1	0.0	17.0	4.5	4.9	-
Juvenile Black	.34	0.0	18.0	4.1	4.2	-
Juvenile Black	.45	0.0	16.0	0.0	2.4	-
Juvenile Black	1.10	0.0	19.0	0.0	6.9	-

KAPUSKASING RIVER

Species and Age	Hg	Pb	Zn	Cr	Cu	Fe
Juvenile Mallard	.79	0.0	19.0	3.0	3.2	-
Juvenile Black	.43	0.0	19.0	0.0	1.90	-
Juvenile Black	.35	0.0	30.0	0.0	3.9	110.0
Juvenile Black	.15	0.0	19.0	0.0	1.7	170.0
Juvenile Black	.07	0.0	17.0	0.0	2.8	110.
Juvenile Black	.13	0.0	21.0	0.0	3.1	140.0
Juvenile G.W. Teal	.12	230.	24.0	0.0	5.0	80.0
Juvenile G.W. Teal	.56	0.0	23.0	0.0	6.8	-
Juvenile G.W. Teal	.21	0.0	23.0	0.0	4.0	65.0
Juvenile B.W. Teal	.58	76.0	21.0	0.0	8.2	-
Juvenile B.W. Teal	.27	1.1	20.0	0.0	3.0	145.
Juvenile Baldpate	.06	0.0	15.0	7.0	2.2	150.0
Juvenile Baldpate	.27	0.0	25.0	0.0	6.3	-
Juvenile Baldpate	.09	0.0	18.0	0.0	4.1	110.0
Adult Mallard	.13	0.0	20.0	-	-	-
Adult Baldpate	1.0	0.0	22.0	0.0	9.1	-

TABLE IV

WATER CHEMISTRY ANALYSES AT SELECTED STATIONS

ON THE KAPUSKASING RIVER

STATION	DATE 1971	COND. UMHO/CM	pH	ALK MG/L $CACO_3$	T.S. MG/L	D.S. MG/L	S.S. MG/L	CA MG/L	MG MG/L	NA MG/L	K MG/L	S04 MG/L
KR	10/8	122.	7.6	60.	80.	70.	10.	24.	1.0	1.0	0.9	9.
K 1	12/8	144.	6.7	57.	175.	160.	15.	28.	2.0	2.0	0.9	14.
K 4	11/8	137.	6.8	55.	165.	160.	5.		3.0	2.0	0.9	21.
K 7	11/8	144.	6.9	57.	180.	165.	15.	26.	3.0	2.0	0.9	16.
K 9	11/8	141.	6.8	57.	185.	165.	20.	27.	1.0	2.0	0.9	16.
K 11												
K 12	11/8	143.	6.9	56.	170.	165.	5.	27.	3.0	2.0	0.9	14.
K 13												
LR	11/8	123.	7.6	63.	120.	110.	10.	24.	3.0	2.0	0.5	7.
K 17	11/8											
K 18	11/8	144.	6.7	58.	170.	165.	5.	27.	2.0	2.0	0.8	13.
K 21	11/8	145.	6.7	58.	155.	140.	15.	24.	4.0	2.0	0.9	13.
K 25	11/8	143.	6.9	79.	160.	155.	5.	26.	2.0	2.0	0.9	12.
K 29	11/8	144.	6.7	60.	155.	150.	5.	26.	2.0	2.0	0.9	15.
K 30												
R												
K 33	13/8	133.	6.8	60.	150.	140.	10.	26.	2.0	2.0	0.8	13.
K 39	13/8	139.	6.9	61.	145.	135.	10.	22.	7.0	2.0	0.8	13.
M 47	13/8	122.	7.4	53.	100.	90.	10.	20.	2.0	3.0	0.9	10.
M 48	13/8	135.	6.9	59.	120.	110.	10.	24.	2.0	2.0	0.9	10.
M 50	13/8	127.	7.2	54	80.	75.	5.	23.	1.0	3.0	0.6	10.

TABLE IV Cont'd

STATION	DATE	CL	FE	KN	NH3	NO2	NO3	PHENOLS	HG	PB	ZN
	1971	MG/L	MG/L	MG/L	MG/L	MG/L	MG/L	UG/L	MG/L	MG/L	MG/L
KR	10/8	2.0	.35	1.60	.10	.008	-.01	7.0	-.01	0.0	0.00
K 1	12/8	4.0	.50	1.10	.01	.007	-.01	12.0			
K 4	11/8	3.0							-.01	0.1	0.00
K 7	11/8	4.0	.80	.95	.05	.007	-.01	12.0	-.01	0.2	0.00
K 9	11/8	3.0	.35	.75	.02	.007	-.01	18.0			
K11											
K12	11/8	4.0	.35	.60	.03	.008	-.01	10.0			
K13											
LR	11/8	2.0	.65	.55	.06	.009	-.01	0.0	0.00	0.1	0.00
K17											
K18	11/8	3.0	.40	.70	.02	.008	-.01	12.0			
K21	11/8	3.0	.55	.50	.01	.008	.01	12.0	-.01	0.1	0.00
K25	11/8	5.0	.40	.65	.01	.008	.01	10.0			
K29	11/8	4.0	.65	.70	.02	.008	.01	12.0			
K30	13/8								0.00	0.0	0.06
R	13/8										
K33	13/8	3.0	.65	.90	.03	.008	.01	7.0			
K39	13/8	3.0	.55	.85	.02	.008	.01	18.0	0.00	0.1	0.00
M47	13/8	2.0	.30	.70	.06	.007	.01	5.0	0.00	0.1	0.00
M48	13/8	2.0	.40	.60	.07	.007	.01	7.0			
M50	13/8	3.0	.30	.45	.05	.007	.01	3.0	0.00	0.1	0.00